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MINERAL INDUSTRY SURVEYS

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NICKEL IN JANUARY 1997

Reported domestic nickel consumption in January, on a daily average basis, was 19% greater than that of December 1996, according to the U.S. Geological Survey. Increases occurred in 9 of the 10 end use categories — the exception being chemicals. The increases reflect, in part, a return to normal work schedules at the end of the holiday season. Daily usage by the stainless steel industry averaged 132 metric tons (t) per day, up 23% from the corresponding December figure of 108 t per day. Consumption of elemental nickel to make nickel-base corrosion resistant alloys increased 28% to 49 t per day. Sales to plating companies averaged 41 t per day, slightly more than in December. Percentages reported in this paragraph may not be verifiable owing to the concealment of company proprietary data. Trade data for January will appear in a subsequent issue.

Inco to use Sumitomo refining process at the proposed Argentia refinery in Newfoundland

Sumitomo Metal Mining Co. Ltd. of Japan has agreed in principle to license its patented matte chlorine leach electrowinning (MCLE) process to Inco Limited. Inco wants to use the hydrometallurgical process in its proposed nickel smelting and refining complex at Argentia, Newfoundland (Inco Limited, 1997). Feed for the Argentia complex would come from Inco's new mine being developed at Voisey's Bay, Labrador.

The nickel-copper-cobalt ore mined at Voisey's Bay would be milled on site. The Voisey's Bay mill would have a differential froth flotation circuit and produce two concentrates—one of pentlandite [$(Fe,Ni,Co)_9S_8$] and one of chalcopyrite [$CuFeS_2$]. Only the pentlandite concentrate would go to Argentia; the current plan calls for the chalcopyrite concentrate to be toll smelted elsewhere. Production of concentrate is scheduled to begin in late 1999.

At Argentia, Inco would convert the pentlandite concentrate into a pebble-sized, granulated nickel sulphide matte, using proprietary flash smelting technology developed in-house (Voisey's Bay Nickel Co. Limited, 1996). The oxygen flash smelting produces a crude iron-nickel-copper matte that has to be processed further in a converter to remove the bulk of the iron. In the converter, oxygen is blown up through the molten matte, oxidizing the iron which then enters the overlying silicate slag layer. After separation of the iron, the nickel-rich matte left in the converter—the Bessemer matte—is ready to be refined and Sumitomo's process enters into the picture.

The Bessemer matte has three principal components: Ni_3S_2, Ni-Cu alloy, and Cu_2S. The MCLE process would be used to leach the nickel, copper, and cobalt from the matte, leaving behind elemental sulfur in a solid phase while simultaneously separating the copper from the nickel and cobalt. The sulfur would be drawn off, melted, filtered, and then pumped back to the smelter's sulfuric acid plant where it would be burned to sulfur dioxide and added to the off-gas feed stream from the flash furnace.

The MCLE process utilizes the cupric-cuprous redox couple to separate the nickel from the copper. The first step in the process is to grind the granulated matte and feed it as a slurry into a two-stage counter-current chlorine leach circuit. The chlorine leach solution contains cupric ion which immediately reacts with the nickel-copper sulfides in the matte. The freshly dissolved copper accelerates the leach process. A series of rapid reduction-oxidation reactions occurs, causing the nickel to dissolve out of the matte and the copper to precipitate out of the leach as a relatively insoluble cuprous sulfide cement. The cobalt is recovered from the copper-free pregnant liquor by precipitation as cobaltic hydroxide. The nickel-rich, cobalt-free chloride solution can now be fed into an electrowinning cell. During electrowinning, some of the chloride ions are oxidized and form chlorine gas. The chlorine gas is removed and

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recycled back to the chlorine leach circuit. The nickel is recovered as nickel metal cathode.

The cuprous sulfide cement and any undissolved nickel sulfides are bled off and fed into the main chlorine leach tank where the chlorine gas from the electrowinning cells are used to reoxidize the cuprous ion. The bulk of the dissolved copper is removed and recovered in a separate electrowinning circuit.

Sumitomo has been using the MCLE process to produce high-quality nickel metal and cobalt at its Niihama refinery in Ehime Prefecture, Japan, since 1992 (Ishikawa, 1994). The process is carried out in a closed system, reducing risk to the environment. The first refined nickel would be available from Argentia in late 2000, with full production in 2001. When fully operational, the complex will be able to process 84,000 t per year of sulfide concentrate and produce 122,000 t per year of refined nickel.

Sumitomo and Inco have been cooperating on projects for more than a decade. In 1988, Sumitomo purchased a 20% interest in P.T. International Indonesia (P. T. Inco) from Inco for $100 million. Prior to the acquisition, P. T. Inco was owned 98% by Inco Ltd. and 2% by a consortium of six Japanese companies that included Sumitomo. The current equity breakdown for P.T. Inco is: Inco, 58.7%; Sumitomo, 20.1%; public shareholders, 20.0%; and four other Japanese companies, 1.2%. The public shares are traded on the Indonesian stock exchanges. P.T. Inco produces matte from lateritic ores at its integrated mine and processing facilities at Soroako on the island of Sulawesi. The Soroako operation supplies much of the matte used at Niihama.

References Cited

Inco Limited, 1997, Inco Limited and Sumitomo Metal Mining Co., Ltd. sign agreement in principle on Sumitomo refining process: Toronto, ON, Inco Limited press release no. 9/97, May 14, 1 p.

Ishikawa, Yukio, 1994, Development and industrialization for a new highly nickel refining process: Metallurgical Review of The Mining and Materials Processing Institute of Japan, v. 11, no. 2, December, p. 1-15.

Voisey's Bay Nickel Co. Limited, 1996, The Voisey's Bay smelter/refinery project [project description report]: St. John's, NF, Voisey's Bay Nickel Co. Limited, December 5, 1996, 77 p.

TABLE 1
CONSUMPTION OF NICKEL (EXCLUSIVE OF SCRAP), BY FORM AND USE 1/

(Metric tons, nickel content)

Period	Cathodes, pellets, briquets, and powder	Ferronickel	Oxide-sinter, salts, and other forms	Total	Total year to date
1996:					
January	6,930	1,500	308	8,740	8,740
February	7,010	1,230	268	8,510	17,200
March	6,760	1,480	318	8,560	25,800
April	6,620	1,490	249	8,360	34,200
May	7,060	1,470	285	8,820	43,000
June	6,710	1,530	236	8,480	51,500
July	6,480	1,160	130	7,770	59,200
August	6,290	1,450	141	7,880	67,100
September	6,030	1,540	178	7,750	74,900
October	6,670	1,750	320	8,740	83,600
November	5,610	1,340	365	7,320	90,900
December	5,630	1,660	181	7,470	98,400
1997:					
January:					
Steel:					
Stainless and heat resisting	2,200	1,900	W	4,100	4,100
Alloy (excludes stainless)	466	W	W	466	466
Superalloys	912	--	W	912	912
Copper-nickel alloys	W	W	--	W	W
Electrical, magnetic, and expansion alloys	W	--	--	W	W
Other nickel & nickel alloys	1,490	W	W	1,490	1,490
Cast iron	W	--	--	W	W
Electroplating (sales to platers)	1,280	--	W	1,280	1,280
Chemical and chemical uses	W	--	W	W	W
Other uses	450	103	101	654	654
Total reported	6,810 2/	2,000	101	8,900	8,900
Total all companies (calc) 3/	XX	XX	XX	13,000	13,000
1997: January	6,810	2,000	101	8,900	XX
1996: January-December	77,800	17,600	2,980	98,400	XX

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Other uses" category. XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Of consumption, 5,460 metric tons were consumed as cathodes and pellets, the remainder as briquets and powder.

3/ Figures represent calculated apparent consumption; based on the revised proportion of reported primary consumption (68.69%) to apparent primary consumption for 1994.

TABLE 2
ENDING STOCKS OF NICKEL (EXCLUSIVE OF SCRAP) HELD BY CONSUMERS, BY FORM AND USE 1/ 2/

(Metric tons, nickel content)

Period	Cathodes, pellets, briquets, and powder	Ferronickel	Oxide-sinter, salts, and other forms	Total
1996:				
January	4,690	329	106	5,120
February	5,060	292	95	5,450
March	4,610	207	69	4,890
April	4,430	131	81	4,640
May	4,060	342	92	4,490
June	3,630	337	91	4,060
July	3,440	516	70	4,030
August	3,350	429	77	3,860
September	2,890	276	82	3,250
October	2,740	473	80	3,290
November	6,190	636	64	6,890
December	4,990	1,540	77	6,620
1997:				
January:				
Steel (stainless, heat resisting and alloy)	2,550	642	(3/)	3,200
Nonferrous alloys 4/	1,700	(5/)	(3/)	1,700
Foundry (cast irons)	(3/)	--	(3/)	(3/)
Chemical (catalysts, ceramics, plating salts, etc.) and unspecified uses	158	--	72	230
Total	4,420	642	72	5,130

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Stocks held by companies that consume nickel in more than one end use category are credited to the major category. Stocks are subject to revision owing to inventory adjustment.

3/ Included in "Chemicals and unspecified uses" category .

4/ Includes superalloys, nickel-copper and copper-nickel alloys, permanent magnet alloys, and other nickel alloys.

5/ Included in "Chemicals and unspecified uses" category of "Oxide-sinter, salts, and other forms" .

TABLE 3
CONSUMPTION AND ENDING STOCKS OF PURCHASED SECONDARY NICKEL, BY USE 1/

(Metric tons, nickel content)

	Consumption			Stocks		
Period	Ferrous scrap 2/	Nonferrous scrap 3/	Total scrap	Ferrous scrap 2/	Nonferrous scrap 3/	Total scrap
1996:						
January	3,430	760	4,190	3,710	121	3,830
February	3,380	1,120	4,500	4,190	114	4,310
March	4,650	965	5,620	3,970	91	4,060
April	3,910	815	4,730	3,730	90	3,820
May	4,100	783	4,880	3,100	100	3,200
June	3,770	625	4,400	3,040	100	3,140
July	3,670	680	4,350	3,290	97	3,390
August	2,860	1,070	3,930	3,350	98	3,440
September	3,490	861	4,350	3,090	109	3,200
October	3,600	762	4,360	3,340	107	3,440
November	3,250	775	4,020	3,630	89	3,720
December	3,310	646	3,960	3,520	88	3,610
January-December	43,400	9,860	53,300	XX	XX	XX
1997:						
January	4,720	796	5,510	3,160	109	3,270

XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Nickel content is calculated from an average nickel content and the reported gross weight of scrap.

3/ Combined consumption and stocks of aluminum-base, copper-base, and nickel-base scrap.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF NICKEL, BY COUNTRY 1/

(Metric tons, nickel content 2/)

Period and country of origin	Cathodes, pellets, and briquets	Powder and flakes	Ferro-nickel	Metal-lurgical-grade oxide	Waste and scrap	Stainless steel scrap	Chemicals	Total 3/	Total year to date 4/	Wrought nickel
1995:										
December	8,930	563	830	25	308	239	210	11,100	157,000	77
January-December	118,000	9,510	16,700	530	4,740	3,190	4,210	157,000	XX	2,310
1996:										
January	11,000	1,030	887	46	333	313	377	14,000	14,000	51
February	9,970	709	1,540	14	309	312	419	13,300	27,200	55
March	9,130	917	2,130	39	385	369	241	13,200	40,400	60
April	11,300	760	980	21	344	313	187	13,900	54,300	52
May	11,000	945	2,020	91	411	319	219	15,000	69,400	72
June	7,750	927	1,430	9	343	289	254	11,000	80,400	43
July	7,230	684	1,470	18	238	274	216	10,100	90,500	42
August	9,250	835	1,120	14	235	319	265	12,000	103,000	44
September	9,390	629	884	33	416	322	234	11,900	114,000	52
October	7,850	779	1,050	60	581	373	311	11,000	125,000	67
November	9,820	670	1,520	99	328	308	290	13,000	138,000	38
December:										
Australia	920	120	--	--	10	--	--	1,050	14,900	--
Brazil	--	--	50	--	--	--	--	50	501	--
Canada	4,740	506	--	21	88	155	22	5,530	58,500	5
Colombia	--	--	301	--	--	--	--	301	1,420	--
Dominican Republic	--	--	618	--	--	--	--	618	9,290	--
Finland	363	136	--	--	--	--	43	542	4,740	--
France	199	--	--	--	90	5	25	319	2,260	7
Germany	23	(5/)	--	--	13	--	26	62	819	39
Japan	--	24	--	--	3	11	15	53	1,160	9
New Caledonia	--	--	--	--	--	--	--	--	4,160	--
Norway	2,620	--	--	--	--	--	--	2,620	24,300	--
Russia	133	18	--	--	--	--	--	151	18,600	--
South Africa	--	--	--	--	--	--	--	--	1,200	--
United Kingdom	37	9	--	--	104	--	20	170	1,940	1
Zimbabwe	138	--	--	--	--	--	--	138	1,730	--
Other	--	2	--	--	44	102	100	249	4,780	1
Total	9,180	815	969	21	351	275	251	11,900	150,000	61
1996: January-December	113,000	9,690	16,000	463	4,270	3,790	3,270	150,000	XX	637
1995: January-December	118,000	9,510	16,700	530	4,740	3,190	4,210	157,000	XX	2,310

XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ The nickel contents are assumed to be as follows: metallurgical-grade oxide (77%), waste and scrap (50%), and stainless steel scrap (7.5%). The chemical category includes chlorides (25%), sulfates (22%), and other salts (22%), supported catalysts (22%), and oxide, sesquioxide and hydroxide (65%).

3/ Excludes wrought nickel.

4/ May include revisions for prior months.

5/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 5
U.S. EXPORTS OF NICKEL, BY COUNTRY 1/

(Metric tons, nickel content 2/)

Period and country of destination	Cathodes, pellets, and briquets	Powder and flakes	Ferro-nickel	Metal-lurgical-grade oxide	Waste and scrap	Stainless steel scrap	Chemicals	Total 3/	Total year to date 4/	Wrought nickel
1995:										
December	21	74	294	471	827	1,800	164	3,650	51,500	147
January-December	1,310	1,230	807	3,500	14,200	27,600	2,920	51,500	XX	475
1996:										
January	7	69	429	262	714	1,570	158	3,210	3,210	22
February	72	53	60	78	903	1,430	305	2,900	6,110	23
March	80	92	181	271	859	1,140	261	2,880	8,990	52
April	149	63	119	134	965	2,760	389	4,570	13,600	27
May	82	171	220	331	782	1,520	519	3,620	17,200	31
June	79	142	73	616	800	1,530	295	3,530	20,700	19
July	7	50	650	480	778	2,650	364	4,980	25,700	30
August	44	97	299	348	703	2,200	424	4,120	29,800	64
September	6	80	179	359	1,210	2,230	292	4,360	34,200	27
October	20	79	359	420	1,280	2,270	185	4,620	38,800	63
November:	19	88	324	517	918	1,610	197	3,670	42,500	59
December:										
Australia	--	(5/)	--	--	19	--	(5/)	20	124	--
Belgium	--	5	--	--	--	1	128	134	388	1
Canada	--	44	--	391	568	148	41	1,190	16,400	1
Germany	1	2	--	--	39	(5/)	--	42	768	(5/)
India	--	1	284	--	--	11	--	296	1,820	(5/)
Italy	--	(5/)	--	--	--	--	--	(5/)	23	--
Japan	--	4	--	--	95	244	35	378	3,880	3
Korea, Republic of	--	1	--	--	--	690	2	692	6,030	--
Mexico	16	3	--	--	--	3	96	118	543	1
Netherlands	--	--	--	--	--	--	--	--	268	(5/)
Spain	--	--	--	--	--	375	--	375	4,860	--
Sweden	--	5	--	--	209	--	--	214	2,670	--
Taiwan	--	1	28	--	4	204	3	240	4,540	1
United Kingdom	1	2	1	2	10	10	14	40	333	5
Other	3	8	120	--	16	161	231	540	4,150	9
Total	21	75	433	393	960	1,850	551	4,280	46,800	21
1996: January-December	586	1,060	3,330	4,210	10,900	22,800	3,940	46,800	XX	439
1995: January-December	1,310	1,230	807	3,500	14,200	27,600	2,920	51,500	XX	475

XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ The nickel contents are assumed to be as follows: metallurgical-grade oxide (77%), waste and scrap (50%), and stainless steel scrap (7.5%). The chemical category includes chlorides (25%), sulfates (22%), and other salts (22%), supported catalysts (22%), and oxide, sesquioxide and hydroxide (65%).

3/ Excludes wrought nickel.

4/ May include revisions for prior months.

5/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF NICKEL ALLOYS, BY COUNTRY 1/

(Metric tons, gross weight)

Period and country of origin	Unwrought alloyed ingot	Bars, rods, and profiles	Wire	Plates and sheets	Foil	Tubes and pipes	Other alloyed articles	Total	Total year to date 2/
1995:									
December	79	183	158	130	3	49	29	632	9,140
January-December	3,000	1,180	2,030	1,510	3	1,040	377	9,140	XX
1996:									
January	114	212	154	116	(3/)	98	43	738	738
February	259	152	75	92	(3/)	65	61	704	1,440
March	300	176	151	123	(3/)	107	58	916	2,360
April	561	180	158	132	(3/)	95	20	1,150	3,500
May	178	249	175	170	(3/)	67	18	858	4,360
June	221	242	116	157	(3/)	71	54	861	5,220
July	188	117	195	90	(3/)	44	107	743	5,960
August	91	219	97	187	(3/)	49	615	1,260	7,220
September	117	70	144	133	(3/)	50	59	573	7,800
October	249	151	120	90	(3/)	72	60	741	8,540
November	349	161	168	81	(3/)	66	29	854	9,390
December:									
Australia	73	--	--	--	--	--	--	73	1,220
Belgium	14	--	--	1	--	--	--	15	188
Brazil	--	--	9	--	--	--	--	9	19
Canada	--	(3/)	8	(3/)	--	7	1	16	306
France	--	4	57	20	--	3	1	85	1,170
Germany	(3/)	72	89	119	--	5	(3/)	285	2,780
Italy	--	38	(3/)	--	--	3	13	54	663
Japan	9	--	3	--	--	8	1	21	323
Mexico	--	--	--	--	--	--	(3/)	(3/)	58
Netherlands	--	--	(3/)	--	--	5	8	13	141
South Africa	--	--	--	--	--	--	--	--	658
Sweden	--	--	76	3	--	8	--	87	625
United Kingdom	56	64	14	1	(3/)	8	25	168	1,590
Other	--	--	(3/)	1	--	--	15	16	497
Total	151	178	256	145	(3/)	48	64	843	10,200
1996: January-December	2,780	2,110	1,810	1,520	2	832	1,190	10,200	XX
1995: January-December	3,000	1,180	2,030	1,510	3	1,040	377	9,140	XX

XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ May include revisions for prior months.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
U.S. EXPORTS OF NICKEL ALLOYS, BY COUNTRY 1/

(Metric tons, gross weight)

Period and country of destination	Unwrought alloyed ingot	Bars, rods, and profiles	Wire	Plates and sheets	Foil	Tubes and pipes	Other alloyed articles	Total 2/	Total year to date 2/
1995:									
December	456	390	173	754	8	117	146	2,040	18,900
January-December	4,170	3,410	1,510	6,230	153	1,240	2,150	18,900	XX
1996:									
January	447	268	59	685	6	118	391	1,970	1,970
February	529	330	70	613	15	205	291	2,050	4,030
March	331	308	121	631	20	100	170	1,680	5,710
April	651	337	138	441	43	149	648	2,410	8,120
May	508	219	149	792	7	89	242	2,010	10,100
June	531	270	155	676	60	81	168	1,940	12,100
July	335	349	148	628	8	84	451	2,000	14,100
August	540	184	176	619	5	96	183	1,800	15,900
September	274	177	166	622	9	78	176	1,500	17,400
October	602	240	147	600	12	49	394	2,040	19,400
November	485	340	113	725	5	74	276	2,020	21,400
December:									
Australia	1	(3/)	1	102	--	--	--	104	1,110
Belgium	9	(3/)	--	1	--	(3/)	--	10	231
Canada	91	16	34	135	6	65	25	372	4,420
France	126	2	(3/)	28	--	(3/)	15	171	2,510
Germany	13	10	7	39	(3/)	(3/)	(3/)	69	693
India	--	--	(3/)	--	--	(3/)	(3/)	(3/)	65
Ireland	--	--	18	(3/)	--	--	(3/)	18	280
Italy	1	(3/)	(3/)	101	--	3	(3/)	105	1,320
Japan	128	(3/)	10	106	(3/)	28	12	284	3,080
Korea, Republic of	(3/)	(3/)	(3/)	92	--	(3/)	14	106	405
Mexico	34	3	15	5	(3/)	13	2	72	1,160
Netherlands	7	28	--	12	--	(3/)	(3/)	47	443
Singapore	(3/)	11	(3/)	(3/)	--	(3/)	(3/)	12	176
Spain	--	1	(3/)	49	--	(3/)	--	51	178
Sweden	--	(3/)	--	3	--	--	1	4	125
Switzerland	3	3	--	4	(3/)	(3/)	4	14	211
Taiwan	--	--	(3/)	17	--	4	11	32	267
United Kingdom	54	79	32	214	--	5	5	389	3,850
Other	11	39	2	63	3	28	40	186	2,960
Total	478	191	119	971	9	146	129	2,050	23,500
1996: January-December	5,710	3,210	1,560	8,000	200	1,270	3,520	23,500	XX
1995: January-December	4,170	3,410	1,510	6,230	153	1,240	2,150	18,900	XX

XX Not applicable.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ May include revisions for prior months.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8
NICKEL CONSUMPTION IN CAST AND WROUGHT PRODUCTS

	Percent	
	Wrought	Cast
January 1997:		
Stainless and heat resisting steels	100	(1/)
Alloy steels	99	1
Superalloys	76	24
Copper-nickel alloys	94	6
Other nickel-base alloys	100	(1/)

1/ Less than 1/2 unit.

TABLE 9
NICKEL PRICES

Date	Cathode NY Dealer $/lb.	LME Cash $/t	LME Cash $/lb.	18/8 Stainless steel scrap Pittsburgh $/long ton(gw)
Yearly average 1996:	3.502	7,500.815	3.402	834
Average for month of:				
December 1996	3.065	6,580.750	2.985	730
January 1997	3.220	7,071.545	3.208	730
February 1997	3.585	7,734.525	3.508	810
For week ending:				
1996:				
December 6	3.14-3.20	6,756.600	3.065	720-740
December 13	3.08-3.17	6,645.700	3.014	720-740
December 20	3.03-3.12	6,534.700	2.964	720-740
December 27	3.02-3.09	6,438.333	2.920	720-740
1997:				
January 3	2.96-3.01	6,359.625	2.885	720-740
January 10	3.04-3.31	6,964.100	3.159	720-740
January 17	3.27-3.43	7,173.600	3.254	720-740
January 24	3.35-3.40	7,217.000	3.274	720-740
January 31	3.35-3.44	7,197.400	3.265	720-740
February 7	3.48-3.59	7,611.500	3.453	800-820
February 14	3.58-3.66	7,702.100	3.494	800-820
February 21	3.59-3.63	7,710.600	3.497	800-820
February 28	3.69-3.75	7,913.900	3.590	800-820

Sources: Platt's Metals Week and American Metal Market.